GRAND TRUNK RAILWAY OF CANADA.

REPORT

ON THE

ST. LAWRENCE BRIDGE & MANUFACTURING SCHEME

(SHEARER SCHEME).

BY

E. P. HANNAFORD,

17th MARCH, 1883.

MONTREAL:
PRINTED BY THE GAZETTE PRINTING COMPANY.
1883.

..AND TRUNK RAILWAY OF CANADA.

REPORT

ON THE

ST. LAWRENCE BRIDGE & MANUFACTURING SCHEME

(SHEARER SCHEME).

BY

E. P. HANNAFORD,

17th MARCH, 1883.

MONTREAL:
PRINTED BY THE GAZETTE PRINTING COMPANY.

1883.

1883
(82)

GRAND TRUNK RAILWAY OF CANADA.

OFFICE OF THE CHIEF ENGINEER,

MONTREAL, *March 17th*, 1883.

TO JOSEPH HICKSON, ESQ.,
General Manager,
GRAND TRUNK RAILWAY COMPANY, MONTREAL.

REMARKS on the REPORT of MR. F. FOSTER BATEMAN, to the Hon. the Minister of Public Works, on the ST. LAWRENCE BRIDGE & MANUFACTURING SCHEME (Shearer Scheme), dated 18th JANUARY, 1882.

It is proposed by the promoters of the Scheme, to construct an embankment obliquely across the River St. Lawrence, from the Western abutment of the Victoria Bridge to a point on St. Helen's Island, a distance of about 9,500 feet, the summit of the embankment to be above the high water level of the River.

This embankment to be solid for its entire length with the exception of

30 Controlling sluices, each 40 feet wide.....	1,200 feet.
35 Milling sluices, each 20 feet wide.....	700 feet.
	1,900 feet.

Giving total openings in length, of about one quarter of the distance to be occupied by the embankment at this site; and through these openings it is proposed to carry nearly as much water as now passes down the channel of the River via the current St. Mary.

These sluices to be opened, closed and regulated at pleasure, and when closed (as all the controlling sluices

are recommended to be in Winter), the South channel, between St. Helen's Island and the St. Lambert shore, is expected to carry the surplus water. The South channel bed is not proposed to be lowered, "because if the bed "of the South channel were lowered by the proposed "scheme, the Harbour would most assuredly be lowered "in proportion."

This is what Mr. Bateman says, and I agree with him. A channel 300 ft. wide, and 10 ft. below the bed of the River, is to be cut in the South channel, so as to afford steamers a runway in Summer, when the River is at the lowest, and when all the sluices are discharging "full into the Harbour."

I propose to consider the Scheme in its two bearings Summer and Winter.

In Summer, Mr. Bateman says he proposes to discharge all the sluices full into the Harbour. We are not told what these sluices will be required to discharge in Summer. But it may be inferred that as the promoters will be glad of all the water at low stages of the River to keep up the level of the Harbour, the South channel will have no serious extra discharge such as to create floods by the overflow or backing of the water.

In Winter and Spring the features become entirely different. The Embankment stretching obliquely across the River from the Western abutment of the Victoria Bridge to St. Helen's Island, may be considered as solid throughout because the sixty-five openings will be packed with ice from top to bottom.

It needs no Engineer to demonstrate this, every "habitant" knows it. It will take place whether the sluices are opened or closed. The *frasil* will form and move into the apertures, and so cement them as to make the raising of the gates extremely difficult, owing to anchor-ice, or if lifted, the apertures will still be blocked

with ice and so materially reduce the quantity of water passing through them.

It may be said, "How is it that water power is furnished throughes flumes " or sluices from the Lachine Canal and other sources in winter ? "

The reply is, that the Lachine Canal is a mill pond of quiet water, its ice is on the surface only, hence the sluice gates work with comparative ease.

The St. Lawrence River will not be a quiet pond, but on the contrary a rushing mass of water and *frasil* under its surface ice intermixed with innumerable blocks of moving ice large and small, ready to rush into the sluice way apertures, there to be mixed with *frasil* and cemented by anchor-ice into a compact mass that will hold down the sluice gates and fill the apertures, like molten lead run into a setting of iron with stone.

But few are aware of what is going on under the St. Lawrence surface-ice, or realise that every winter the *frasil* ice forms under the surface ice and clings to it, making a mass at some points extending to the very bottom of the river.

At the Victoria Bridge, in February of this year, I found the surface ice 3 feet thick, and in some places the *frasil* ice was nine feet thick below it. This was observed where the stream was rushing with a velocity equal to a torrent. The *frasil* ice holds its position, for it clings to the surface ice, the water in its rush becoming excellent material for making more anchor ice, because such ice only forms were water is agitated, not where it is in repose.

It is, therefore, no assumption, or an engineering theory that these sluice-ways would be blocked with *frasil*, but is a fact patent to every one conversant with our climate. Therefore we must now see where the winter and flood water of the St. Lawrence would go.

It could not go *over* the embankment, because the summit will be above flood level, and therefore the only other passage way is by the South channel.

Now what would be state of this channel in such a case? It would have to carry its own flood water as well as that of the current of St. Mary. In fact the South channel would have to carry all the water of the river with the ice, both surface and *frasil*.

The effect of forcing the full discharge of the St. Lawrence into a channel which in winter is usually choked with *frasil* to the bottom, would be an experiment fraught with very great danger to the adjoining neighbourhood.

It is true that "water finds its own level," and without going into intricate calculations to prove what the level of the back water would be raised to by the proposed scheme, I am satisfied from experience that to direct the whole of the waters of the St. Lawrence in winter into the South channel, would increase the height of the water at the Victoria Bridge and Laprairie Basin, and that floods such as frequently occur would be greatly increased in the neighbourhood of St. Lambert, Laprairie, and Point St. Charles, to the serious injury of the property of the Railway Company and other proprietors.

Mr. Bateman says that the water will be raised 4 ft. 6 in. at the Victoria Bridge, but that this will not affect the low lands around Lapraire. But as the winter level of Laprairie Basin is now level with, and floods the low-lands when the water at the Victoria Bridge is only two feet below the level of Laprairie Basin, it becomes self-evident that the contemplated rise of 4½ ft. at the Victoria Bridge will back up the water at Laprairie to a greater extent. To fix, however, the exact limit of the backing of water by ice-jams and gorges is impossible.

At Laprairie, the low-lands traversed by the Railway have been inundated to an alarming extent, causing serious

anxiety to the neighbourhood and to the Railway Company. The inhabitants feared that the waters of the St. Lawrence would flow into the Chambly Basin.

It would be granting a very dangerous power to concede authority to carry out a scheme such as proposed, when the result of it must be to increase the overflow of the river.

I will not dwell on the position of the South shore lands below the Victoria Bridge beyond saying that as the level of the river is sometimes only a few feet below the South shore, it follows, that with "all the main ice of the River "St. Lawrence passing down the South channel instead "of passing through the Harbour," (this is what Mr. Bateman says), such ice will gorge the South channel to its bottom; and as its bed is of rock the pressure on the sides would tear away the shores or dam the back water and overflow the adjoining lands.

The construction of levees would not prevent the ice scaling the shores and Railway works; whilst the water backed up by the rising ice would pour into every local channel and ditch with disastrous results.

As to the damage by ice to the Victoria Bridge by throwing all the water into the South channel, the Bridge structure is a strong one and may be considered able to take care of itself. But as ice has been known to pile up and strike the tubes and climb over the approaches, I certainly advise the Company to resist any scheme tending to increase the height of water at its site.

The winter and summer discharge of the St. Lawrenec is varied by rain fall, winds, melting of snow and blocking of ice. Ice is the chief factor in producing these fluctuations.

It commences forming early in winter under the surface ice and piles up until it gorges the channels. The river discharge has either to clear away the ice or raise its own level. It does the latter because with the ice so

formed and packed it is the easiest way of obtaining vent, thus all the winter the ice level is continually changing in proportion as the ice or the water gets the mastery in the channels.

In the spring when the ice runs are augmented by additional packs from above, and the channels below are still more gorged with ice, the river rises higher and higher until the pressure or head breaks or overflows the dam.

The Niagara river at Fort Erie, at the site of the International Bridge, has a width of 1850 feet, and a depth of water at its centre of 45 feet. Through this channel there passes per second 1,535,040 gallons (see Colonel Gzowski, M.I.C.E. & M.A.S.C.E. on International Bridge, 1873.)

This is equivalent to 884 millions of cubic feet per hour. Now the Niagara river at this point does not freeze from shore to shore; in fact only shore ice is formed and that by reason of the Bridge works; and Colonel Gzowski says the variations in its surface (leaving out of consideration the sudden rises and falls caused by storms, etc.,) are not more than two feet.

Here we have an example of the kind of channel required to pass ice, viz., a deep one, and it is this depth, added to the current, that enables the Niagara river to discharge its waters in winter without affecting its height.

Take the great rivers of the North, the St. Clair, the Niagara, and St. Lawrence, and it will be seen that they plough for themselves channels of depth, rather than spread out into additional surface area to pass their discharges; and this element of depth varies with the velocity of the stream.

The St. Clair Flats are remarkable examples of this power of ice to cut out channels. The clay is hard and indurated, yet the ice has carved out passages thirty feet deep and these apart from the main river, or International

boundary. I refer to such as the "Basset Channel" which is narrow with banks, where the ice impinges, perpendicular, in some cases overhanging, with sides so hard as to be reliable for standing on to the very edge.

In the river St. Lawrence, at Montreal, similar features exist, the South channel being broad and shallow but with a hard, rocky bottom. When the ice became gorged in this channel an additional flow of it had to carve an outlet in softer material, which it found on the West or North shore (St. Helen's Island being too hard). It was by such a process that St. Mary's channel became the natural one for the ice to pass, and it now possesses the requisite qualities of depth with sufficient current.

To close this natural channel for carrying ice, and to force all the ice down the South channel, would be work ing against nature. The ice would have to seek some other outlet when it gorged in this channel, which it certainly would; and the backing up of water and overflowing would be the result, one upon the extent of which although differences in opinion may exist, must be admitted to contain elements of great danger.

I have avoided engineering formula or abstruse figures, and have confined myself to the "Shearer Scheme," as to its probable effects on the property of the Railway Company and the properties traversed by it, any of the features I have questioned being with the object to prove results and the consequences therefrom, but perhaps I may be allowed to say a few words on the general scheme in its summer aspect.

The promoters' engineer intends to make the sluices with a total capacity of 850 millions of cubic feet per hour (equal to the total discharge of the Niagara river over the Falls) and we may reasonably infer that he intends passing thatquantity of water through them; in fact he says: "in the Summer when all the sluices are discharging full into the Harbour."

Now the present summer discharge through the St. Mary's channel may be taken at one hundred millions of cubic feet per hour; therefore the promoters intend passing through this channel say four fifths of its present discharge.

The present velocity of the St. Mary's channel is stated to be 8½ miles per hour, and its future velocity is calculated by Mr. Bateman at 5 miles per hour.

How this result can be arrived at I cannot understand, because it is self evident that a reduction in speed of 3½ miles per hour is not to be gained by a reduction in the discharge of say 150 millions of cubic feet of water per hour.

Mr. Bateman also says, that an additional quantity of 85 millions of cubic feet per hour is to pass through into the Harbour; thereby with what will pass through the sluices, increasing the discharge into the Harbour to 935 millions of cubic feet per hour, exclusive of the Lachine Canal. These 85 millions are to come around the foot of St. Helen's Island and must consequently pass up stream to get "through into the Harbour."

I cannot believe that thinking men will be carried away by this theory; but will take the broad practical view that running water around the foot of St. Helen's Island up stream into the Harbour is not practicable.

The down current through St. Mary's channel of 850 millions of cubic feet would overpower the 85 millions at Ile Ronde in its endeavour "to pass through into the Harbour," and in order to pass the 850 millions of cubic feet of water per hour down the St. Mary's channel, it must be evident that the present current cannot be materially reduced, and if the current is materially reduced, say from 8½ miles per hour to 5, as Mr. Bateman says, then it can only be done by decreasing proportionately the quantity of water passed through the channel which means the lowering of the water in the Harbour and passing more water down the South channel

The following gives the waterway at the Victoria Bridge :—

	ft.	in.
Distance between the abutments face to face	6,567	3
Deduct Piers	444	9
Available water way	6,122	6

	Square feet
Sectiona. area of water way at	
Mean summer level	50,000
Ditto, average winter ice level	106,000

It will thus be seen that the sectional area way at the Victoria Bridge is double in winter what it is in summer, and yet no more water is passed through the Bridge openings in winter than in summer, the ice in winter controls it, and were it not for the St. Mary's chann' carry off the ice and water, it must be apparent to l, that the South channel could not do the work without go ing, backing up, and over-flowing. Even now du ng an ordinary spring shove, the ice is carried up alo g the shores to the Banks and highway; and what the result would be with all the St. Lawrence discharging through the South channel, and additional obstruction in it from Bridge piers is beyond my ability to estimate.

I do not, however, hesitate to s ate that the damage to the public and to the Railway Company would be most serious, and I consider it incumbent upon the Grand Trunk Railway Company to take every legitimate means to prevent the proposed scheme being carried out.

E. P. HANNAFORD,

Chief Engineer,

GRAND TRUNK RAILWAY CO.